

**SYSTEMS AND METHODS FOR STORING ITEMS WITH CONTAINERS**

**CROSS-REFERENCE TO RELATED APPLICATION**

5        This application is a Continuation-in-Part Application based on and claiming priority to  
U.S. Patent Application entitled “Systems and Methods for Storing Items with Containers,”  
having serial number 10,262,314, filed on October 1, 2002, which is a Continuation-in-Part  
Application based on and claiming priority to U.S. Patent Application entitled, “Systems and  
Methods for Storing Items with Containers,” having serial number 10/236,764, filed on  
10      September 5, 2002, now U.S. Patent No. 6,557,370, issued on May 6, 2003, which is a  
Continuation-in-Part Application based on and claiming priority to U.S. Patent Application  
entitled “Systems and Methods for Storing Items with Containers,” having serial number  
10/135,606, filed on April 30, 2002, now U.S. Patent No. 6,502,417, issued on January 7, 2003,  
which is a Continuation-in-Part Application based on and claiming priority to U.S. Patent  
15      Application entitled, “Transport Container,” having serial number 09/817,680, filed on March  
26, 2001, now U.S. Patent No. 6,401,484, issued on June 11, 2002, which is a Continuation-in-  
Part Application based on and claiming priority to U.S. Patent Application entitled, “Re-  
Freezable Beverage Cooler,” having ser. no. 09/409,319, filed September 30, 1999, now U.S.  
Patent No. 6,216,487, issued on April 17, 2001, each of which is incorporated herein by  
20      reference.

## BACKGROUND OF THE INVENTION

## FIELD OF THE INVENTION

5       The present invention generally relates to containers and, in particular, to systems and methods that utilize containers for storing items so that the temperature of the items may be maintained, raised and/or cooled as desired.

## DESCRIPTION OF THE RELATED ART

10     Oftentimes, it is desirable to transport items, such as beverages, for example, in a portable container or cooler so that convenient access to the beverages is provided, such as while playing golf, attending sporting events, going to a beach, etc. Hereinbefore, such a container typically has been formed of either insulating material, for maintaining the temperature of previously chilled beverages, or a combination of insulating material and cooling material, such as blue ice, for 15 instance, whereby the cooling material chills a beverage stored within the container and the insulating material tends to maintain the temperature of both the cooling material and the chilled beverages.

For example, U.S. Patent No. 4,741,176, issued to *Johnson, et al.*, discloses a beverage cooler, which includes a cylindrical freezer-pack insert to be placed into a cup, and a cover. In an 20 embodiment of the *Johnson* device, the cylindrical freezer-pack insert includes removable sections to change its size, and removable plugs for putting coolant fluid into the removable sections. Since, however, the *Johnson* device is adapted for inserting within an individual cup, the device is limited for use in cooling one beverage at a time.

As another example, U. S. Patent No. 4,295,345, issued to *Atkinson*, discloses a cooling container for canned beverages. The *Atkinson* device includes a reusable concave container for carrying and cooling canned beverages having a bottom section containing a plurality of cylindrical compartments, a top section containing corresponding compartments having a slow warming 5 cooling gel in the upper end thereof, and a shoulder strap for carrying the container. While it is apparent that the *Atkinson* device addresses the problem of cooling multiple beverages simultaneously, it does not, however, provide for increased cooling efficiency of the beverages stored therein, as the cooling gel is stored only in the upper end of the container.

It also may be desirable to transport other items in a portable container. By way of 10 example, various items, such as fluids, organs and/or other medical-related items, may require transport. Heretofore, these items typically have been transported within containers that are not specifically adapted for these items. This inadequacy also is prevalent in fields other than the medical industry.

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#### BRIEF SUMMARY OF THE INVENTION

Containers and methods involving the use of such containers are provided. An embodiment of a container for storing an item comprises: an insulating material defining an interior, the insulating material comprising a bio-based polyurethane; and a temperature-maintaining material disposed within the interior, the temperature-maintaining material being arranged to maintain a temperature of an item placed within the interior. 20

An embodiment of a method comprises: providing a container, the container having: an insulating material defining an interior, the insulating material comprising a bio-based polyurethane; and a temperature-maintaining material disposed within the interior, the temperature-maintaining material being arranged to maintain a temperature of an item placed with the interior.

Other systems, methods, features, and advantages of the present invention will be or become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, features, and advantages be included within this description, be within the scope of the present invention, and be protected by the accompanying claims.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The invention can be better understood with reference to the following drawings. The components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. In the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. 1 is a partially cut-away perspective view of a preferred embodiment of the present invention with representative beverage containers shown in phantom lines.

FIG. 2 is a partially cut-away, perspective view of an alternative embodiment of the present invention with representative beverage containers shown in phantom lines.

FIG. 3 is a partially cut-away, perspective view of an alternative embodiment of the present invention with representative beverage containers shown in phantom lines.

FIG. 4 is a partially cut-away, perspective view of an alternative embodiment of the present invention with representative beverage containers shown in phantom lines.

5 FIG. 5 is a partially cut-away, perspective view of an alternative embodiment of the present invention with representative beverage containers shown in phantom lines.

FIG. 6 is a perspective view of an alternative embodiment of the present invention.

FIG. 7 is a partially-exploded, cut-away, side view of the embodiment depicted in FIG. 6.

10 FIG. 8 is a perspective view of the embodiment depicted in FIGs. 6 and 7, showing the lid in an open position.

FIG. 9 is a preferred embodiment of the item retainer, which may be utilized in the container of FIGs. 6 – 8.

FIG. 10 is a partially-exploded, schematic view of another embodiment of a container of the present invention.

15 FIG. 11 is a partially-exploded, schematic view of another embodiment of a container of the present invention.

FIG. 12 is a partially-exploded, schematic, cut-away view of the embodiment of FIG. 10.

FIG. 13 is a schematic, cut-away view of a sidewall of an alternative embodiment of a container of the present invention, showing insertion of temperature-maintaining material within a 20 temperature-maintaining material chamber.

FIG. 14 is a schematic, cut-away view of a representative sidewall of an alternative

embodiment of a container of the present invention.

FIG. 15 is a schematic, cut-away view of a representative sidewall of an alternative embodiment of a container of the present invention.

FIG. 16 is a schematic, plan view of an embodiment of the present invention in an  
5 unassembled or unfolded configuration.

FIG. 17 is a schematic, plan view of an alternative embodiment of the present invention in  
an unassembled or unfolded configuration.

FIG. 18 is a schematic side view representative of both the embodiment of FIG. 15, as  
viewed from line A-A, and the embodiment of FIG. 16, as viewed along line B-B.

10 FIG. 19 is a schematic side view showing a stacking arrangement of containers of the  
invention.

FIG. 20 is a schematic side view showing another stacking arrangement of containers of the  
invention.

15 FIG. 21 is a partially cut-away, schematic view showing assembly detail of sidewalls of an  
embodiment of the present invention.

FIG. 22 is a schematic, cut-away view of an alternative embodiment of the container of the  
present invention.

FIG. 23 is a flowchart depicting functionality of a method in accordance with the present  
invention.

20 FIG. 24 is a flowchart depicting functionality in accordance with another method of the  
present invention.

FIG. 25 is a flowchart depicting functionality in accordance with still another method of the present invention.

FIGs. 26-33 are graphs depicting time versus temperature involving storage of items in various embodiments of the present invention.

5 FIG. 34 is a schematic diagram depicting an embodiment of a transportation process.

FIG. 35 is a flowchart depicting functionality of an embodiment of a transportation process.

FIG. 36 is a schematic diagram depicting an embodiment of a transportation process.

#### DETAILED DESCRIPTION

10 Reference will now be made in detail to the drawings, wherein like reference numerals indicate like parts throughout the several views. As shown in FIG. 1, a preferred embodiment of the cooler 100 of the present invention incorporates an outer shell 20, preferably formed of a durable material, such as molded plastic, or other suitable materials, and which defines an interior.

15 Preferably, one or more storage chambers 70 are provided within the interior. Storage chambers 70 preferably are adapted to receive one or more beverage containers 90, such as conventional cans or bottles, with the cooler being constructed so as to chill the beverages containers 90, and/or maintain the beverages of the containers 90 at a suitable chilled temperature, as described hereinafter.

20 Access to the storage chamber(s) 70, such as for the insertion and/or removal of beverage containers 90, preferably is facilitated by one or more caps 80 which removably engage the shell 20. For example, in the preferred embodiment depicted in FIG. 1, a plurality of caps 80 are provided along a lower surface of the shell 20, with each of the caps being constructed as a "screw-

"off" cap so that engagement of each of the caps with the shell is facilitated by rotating the cap relative to the shell. However, in other embodiments, engagement of the cap and shell may be facilitated by a friction fit, or other suitable means.

Preferably, storage chamber(s) 70 are defined by inner walls of a re-freezable material

5 chamber 50 which is adapted to receive and retain a quantity of re-freezable material 30.

Preferably, the re-freezable material chamber 50 is adapted to conform to the exterior surface of a beverage container 90 and, therefore, fills the interstices formed between the various containers.

Preferably, in embodiments which are adapted for receiving one beverage container within each storage chamber, each beverage container is surrounded and engaged by the inner wall of the re-freezable material chamber, i.e., on all of its sides and its top.

10 An insulation chamber 40 preferably is provided between the re-freezable material chamber

50 and the shell 20. Preferably, insulation chamber 40 is filled with an efficient insulating material

60, such as polyurethane foam or other suitable material. So configured, each beverage container

inserted within a storage chamber 70 is encased by a layer of re-freezable material, as well as within

15 a layer of insulation for maintaining the temperature of the re-freezable material at a suitable

temperature.

Additionally, cooler 100 may be provided with a handle 10 so that the cooler is easily

transportable. The handle may be formed of numerous suitable materials, such as plastic or leather,

for instance, and may be fastened to the cooler in any conventional manner so that the weight of the

20 cooler and any beverage container stored therein does not cause the handle to separate and detach

from the shell 20.

As depicted in FIGs. 2 - 5, various numbers and arrangements of storage containers 70 may be provided for storing and cooling various numbers of beverage containers 90.

Reference will now be made to FIGs. 6 – 9, which depict a representative alternative embodiment of the cooler of the present invention. As shown in FIG. 6, cooler 100 includes an outer shell 110 and a lid assembly 120. As described in greater detail hereinafter, shell 110 and lid 120 cooperate to form a protective enclosure for transporting and/or storing items placed within an interior of the container. Preferably, shell 110 is formed of a substantially rigid material that is adapted for protecting items placed within the container. Additionally, lid 120 preferably is formed, at least partially, of substantially rigid material.

As shown in FIG. 6, lid 120 incorporates a cap or door 130 that is adapted to alternately provide and deny user access to the interior of the container. In the embodiment depicted in FIG. 6, door 130 includes a recess 140 that is adapted to receive the fingers of a user so that the user may urge the door from its closed to its open position.

Referring now to FIG. 7, assembly of the container 100 will be described in greater detail. As shown in FIG. 7, a layer(s) of insulation 150 preferably is disposed within the interior of the container. In some embodiments, insulation 150 is provided adjacent an interior surface of the outer shell. An insert 160 is adapted to be received within the interior. The insert defines a storage chamber 170, which is adapted to receive one or more items. Re-freezable material 180 preferably is disposed between an exterior surface of the insert and the layer(s) of insulation 150. Engagement of the insert with the outer shell also may tend to retain the insulation 150 and re-freezable material 180 in position within the interior.

As shown in greater detail in FIG. 7, lid 120 includes a top 190 as well as door 130. Top 190 is adapted to engage the outer shell so as to provide a mounting platform for the door. In some embodiments, a gasket 200 is provided between the top and the insert.

Insulation also may be provided within the door. More specifically, the door may be  
5 formed with an insulation-receiving recess 210 that is sized and shaped for receiving a layer(s) of insulation 220. In order to maintain the insulation 220 in position relative to the door, a door insulation retainer 230 may be provided that is adapted to securely engage the door.

In order to facilitate moving the door from its closed position (depicted in FIG. 6) to its open position (depicted in FIG. 8), pivots 240 of the door are received within orifices 245 so as  
10 to enable pivoting of the door about the pivots. In some embodiments, a spring 250 is provided for securing the door in the closed position. In particular, spring 250 urges a latch 255 of the door toward engagement with a recess 265. Thus, when the latch and recess are aligned, the latch forms an interference fit, thereby tending to maintain the door in its closed position.

As shown in FIG. 7, a handle assembly may be provided for facilitating transport of the container. Preferably, handle assembly 270 includes a strap portion 275. Each end of the strap portion preferably is adapted to engage a strap guide 280 of the container, which may be formed on the lid, for example. In some embodiments, a handle may be provided at an intermediate portion of the handle assembly. In these embodiments, the handle 285 preferably is formed of a substantially rigid material and is mounted to the strap so as to provide a portion of the handle assembly that is readily suited for grasping by the hand of a user. In the embodiment depicted in FIG. 7, ends of the strap are secured to the strap guides by hook and loop material 290 although,

in other embodiments, various other mechanisms for securing the strap to the container may be utilized.

As shown in FIGs. 8 and 9, the container 100 may be configured with an item-receiving retainer 300. Item-receiving retainer 300 defines one or more item-receiving cavities 310 that 5 may be specifically sized and shaped to conform to an exterior surface of an item to be received therein. For example, the item-receiving cavities 310 depicted in FIG. 8 are each specifically configured to receive a test tube or vial 320. Preferably, an exterior surface of the item-receiving retainer is adapted to engage an interior surface of the insert and is configured so that cooperation of the lid and the outer shell maintains the item-receiving retainer within the storage chamber.

10        In addition to substantially maintaining relative positions of items stored within the container, the material of the item-receiving retainer may be suitably selected so as to provide shock absorbing. In these embodiments, such as those embodiments formed of a foamed material, for example, the item-receiving retainer may reduce the tendency of an item to break within the container.

15        In some embodiments, various configurations of item-receiving retainers may be provided. More specifically, multiple item-receiving retainers may be provided with a given container, with each item-receiving retainer being adapted to receive various configurations of items for storage within the container. So provided, the container may be adapted so as to specifically accommodate transporting and cooling of particularly sized and shaped items.

20        Another embodiment of a container in accordance with the present invention is depicted schematically in FIG. 10. As shown in FIG. 10, container 100 includes an outer shell 321 that is

sized and shaped to receive an insert 322. When insert 322 is received by shell 321, a gap 323 is formed. Insulation (not shown) can be placed in gap 323 between the outer shell and the insert.

Container 100 of FIG. 10 also includes a storage chamber 324 that is defined by an inner shell 325. Inner shell 325 is received by insert 322 so that a second gap 326 is formed. Gap 326 is adapted to receive temperature-maintaining material (not shown) so that the temperature-maintaining material is located about the sides and/or bottom of an item placed within the storage chamber.

Access to the storage chamber is provided by a removable lid 327. Lid 327 can optionally house insulation and/or temperature-maintaining material. In the embodiment of FIG. 10, the lid includes a nozzle 328 that allows liquid to be drawn from the storage chamber when in an open position. So configured, the container can be used to store various types of items, such as liquids (which can be accessed via the nozzle) and beverage cans (which can be accessed by opening the lid).

Note, the outer shell, insert and inner shell can be held in an assembled configuration by various techniques. For instance, when a foam-type insulation is used, the foam can be injected into gap 323 so that a portion of the foam contacts the inner shell. This enables the insulation to perform as an adhesive for bonding the inner shell to the outer shell and insert.

Reference will now be made to FIGs. 11 and 12, which depict another embodiment of a container 100 in accordance with the present invention. As shown in FIG. 11, container 100 includes multiple side surfaces that extend upwardly from a base (shown more clearly in FIG. 12). In particular, container 100 includes sidewalls 330, 332, 334 and 336, each of which

extends upwardly from base 340. The sidewalls and the base define an interior storage chamber 342 that can be enclosed when a lid 344, *e.g.*, a removable lid, is used to engage the sidewalls.

As shown in FIG. 12, the base, sidewalls and lid are shaped to interlock with each other so that temperature-maintaining material 350 surrounds the storage chamber. More specifically, 5 each of the base, sidewalls and lid includes a temperature-maintaining material chamber, *e.g.*, chambers 352, 354, 356 and 358, that retains temperature-maintaining material. By way of example, the temperature-maintaining material can be a refreezable material.

Preferably, each of the base, sidewalls and lid, in addition to incorporating a temperature-maintaining material chamber and associated temperature-maintaining material, includes an 10 insulation chamber (360, 362, 364, 366) with insulation 370 arranged therein. Note, the various chambers can be defined by a substantially rigid material that also can be used to form the exterior shell 372 of the container.

Attachment of the base, sidewalls and lid to each other can be accomplished in numerous manners. By way of example, one or more of the sidewalls could be hingedly attached to the 15 base. Hinged attachment can be facilitated by hinge mechanisms (not shown) or by a portion of the material of the exterior shell (not shown), for example, that is adapted to flex or bend to accommodate movement of the sidewall with respect to the base. Note, several different attachment configurations will be described later.

As shown in FIG. 13, a container of the invention can include one or more temperature-maintaining material chambers that are adapted to permit removal of the temperature- 20 maintaining material. As shown in FIG. 13, this can be accommodated by a sidewall 374

including an opening 376. The opening 376 is sized and shaped so that the temperature-maintaining material 350 can be removed, such as for freezing, and then re-inserted into the chamber through the opening for use. Note, depending upon the type of temperature-maintaining method used, the material may be packaged so that it does not break apart.

5        Various insulation and temperature-maintaining materials can be used. For example, polyurethane foam can be used as the insulation, and a gel-forming polymer such as polyacrylate/polyalcohol copolymers can be used as the temperature-maintaining material. Clearly, various other materials could be used depending upon characteristics such as the intended operating temperature range, desired weight of the container, and stability/compatibility  
10      within the item(s) stored, among others. The selection of the particular materials is considered within the knowledge of one of skill in the art.

Clearly, various other arrangements can be used for providing the outer shell, insulation, and temperature-maintaining material so that an item placed within the storage chamber of the container can be protected and/or have its temperature maintained. Cut-away views of additional  
15      configurations are depicted in FIGs. 14 and 15.

As shown in FIG. 14, insulation 370 and temperature-maintaining material 350 are arranged between an outer wall 380 and an inner wall 382 of a container. Of particular interest, a gas chamber 384 is provided between the insulation and temperature-maintaining material. The gas chamber is adapted to receive gas 386, such as an inert gas, or other gas that is considered  
20      suitable for increasing the insulating properties of the container. Depending upon the particular properties of the insulation and temperature-maintaining material, these materials may be

adequate for defining the gas chamber and maintaining the gas therebetween.

Another embodiment that includes a gas chamber is depicted in FIG. 15. As shown in FIG. 15, the gas chamber 388, which is located between the insulation 370 and the temperature-maintaining material 350, is defined by an inner wall 390 of the insulation chamber 392 and an outer wall 394 of the temperature-maintaining material chamber 396. Thus, this embodiment 5 uses additional structural elements for maintaining the location of the gas.

As shown in FIG. 16, the base 400 and sidewalls 402, 404, 406 and 408 of a container 100 are depicted in a disassembled or unfolded configuration. In this configuration, the sidewalls and base exhibit a generally flattened structure. Note, the lid 410 is not attached to the base- 10 sidewall assembly 412. Note, hinge mechanisms 414, 416, 418 and 420 attach the sidewalls to the base. The embodiment of FIG. 16 also includes a hanging component 422, which in this case is a ring that can be used for hanging the container during storage, for example. For instance, the ring could attach the container to a hook suspended within a freezer.

FIG. 17 also depicts an embodiment of a storage container 100 in its disassembled or 15 unfolded configuration. In particular, sidewalls 430, 432, 434 and 436 are attached to base 400. Compared to the embodiment of FIG. 16, however, the embodiment of FIG. 17 includes a lid 442 that is hingedly attached to the unfolded structure. In particular, the lid is attached to sidewall 436.

In those embodiments that are configured to unfold into a generally flattened structure, it 20 is shown that the space taken up by the structure is somewhat less than that used when the sidewalls and lid are assembled, such as depicted in FIG. 11. This unfolded configuration is

considered advantageous, in that less volume is required within which to place the container. By way of example, when multiple containers are to be placed within a freezer so that the temperature-maintaining material can be frozen, more containers can be placed within the freezer in the unfolded configuration than would otherwise be able to be placed in the freezer when the 5 containers are assembled.

As shown in the schematic side view of FIG. 18, the lid 450, base 452, and/or one or more of the sidewalls 454 of a container 100 can include protrusions 456 that extend outwardly from an exterior surface 458 of the container 100. These protrusions can be used to form air flow channels 460 between the containers and the surface 462 upon which it is placed. Clearly, the 10 number and arrangement of protrusions can vary among embodiments. Preferably, the protrusions are arranged in rows that are spaced parallel from each other.

In FIG. 19, two containers (100A, 100B) are shown stacked one upon the other. In this arrangement, air (depicted by arrows) is able to flow between the containers, as well as between the lowermost container and surface 462.

15 As shown in FIG. 20, embodiments of containers 100 also can incorporate recesses 470, which are complimentary shaped with respect to the protrusions 456. Thus, the containers (100C, 100D) can nest within each other. Stacking the containers in a nested configuration enables the containers to take up less space, such as during shipping when they are not in use.

As depicted in FIG. 21, the sidewalls can incorporate mating components that are adapted 20 to mate with each other to form a more rigid assembly and/or complete seal about the storage chamber. As shown in FIG. 21, sidewall 480 includes a protruding member 482, while sidewall

484 includes a complimentary shaped recess 486. The protruding member is received by the recess as the sidewalls are assembled, such as by moving sidewall 484 in the direction indicated by the arrow receiving the protruding member. In some embodiments, the protruding member and recess can include surfaces for forming an interference fit when the protruding member is inserted within the recess. Thus, by inserting the protruding member within the recess and forming the interference fit, a tendency for the sidewalls to separate from each other during use can be reduced.

Another embodiment of a storage container 100 is depicted schematically in FIG. 22. As shown in FIG. 22, storage container 100 defines an interior 488 within which items (not shown) can be placed. Temperature-maintaining material can be placed at various locations of the storage container. In the embodiment depicted in FIG. 22, temperature-maintaining material 490 is located at a bottom of the container, temperature-maintaining material 491 is located at the top of the container, temperature-maintaining material 492 is located at a first side of the container and temperature-maintaining 493 is located at a second side of the container. Also depicted in FIG. 22 is temperature-maintaining material 494 that is placed within the interior 488 and which, preferably, is not secured to the container. In particular, temperature-maintaining material 494 is stored within a container 495 that can be a bag or other structure that substantially retains the temperature-maintaining material. Typically, the container 495 is enabled to be moved about the interior although, in some embodiments, the container may be adapted to be maintained in a particular position within the interior.

Clearly, in other embodiments, temperature-maintaining material can be placed in one or more of the positions identified in FIG. 22. Note, the shape, size and/or thickness of the temperature-maintaining material can differ between embodiments.

Various materials can be used for forming embodiments of containers in accordance with 5 the invention. By way of example, insulation that is incorporated into and/or forms the walls, top and/or bottom of a container can be formed, at least partially, of urethane and/or bio-based urethanes, *e.g.*, soyoyl polyol. Of particular interest is the use of bio-based urethanes, *e.g.*, soyoyl polyol foam, as this material is biodegradable. Thus, biodegradable containers that are suitable for one-time use can be provided. In some of these embodiments, an outer shell can be 10 used. For instance, a biodegradable material such as cardboard could be used as an outer shell that protects the insulation.

By way of further example, insulating materials may comprise bio-based polyurethanes. For instance, polyurethanes that comprise vegetable oil can be used. Non-limiting examples of 15 vegetable oils include soybean oil, palm oil, peanut oil, rap seed oil, sunflower oil and linseed oil. Additionally or alternatively, other oils can be used, such as castor oil and lard.

Note, in the function of polyurethanes, polyols are used. Thus, the aforementioned and/or other oils can be used to form polyols. An exemplary method for forming polyols is provided in U.S. patent Application 20030088054 to *Chasar*, which is incorporated by reference herein.

Bio-based insulating materials also can comprise starch, such as from potatoes, or can 20 comprise other natural materials, such as limestone.

Typically, embodiments of containers in accordance with the invention include multiple material layers. Various materials and/or combinations of materials can be used to form each of the layers, with each of the layers performing one or more of the following functions: providing structural support for the container, insulating the container and protecting the container.

5        With respect to supporting the container structurally, various materials can be used. By way of example, bio-based urethanes, *e.g.*, soyoyl polyol foam, urethane foam, polystyrene and cardboard are considered useful as these materials are relatively light in weight, are relatively rigid and suited for the application of coatings (described later). Additionally, bio-based material, *e.g.*, soyoyl polyol, urethane and polystyrene offer improved insulating properties and, 10 thus, can enhance the insulative characteristics of the containers in which they are incorporated.

15      Various materials can be used to insulate the containers. In some embodiments, insulating properties of the containers are enhanced by one or more material layers in addition to the material(s) used to provide structural support for the container (described before). For example, one or more layers of bio-based materials, *e.g.*, soyoyl polyol, urethane foam and/or polystyrene can be used. Additionally or alternatively, other materials, such as those applied as 20 coatings, can be used. By way of example, coatings that incorporate ceramics, such as SUPERTHERM™ manufactured by Superior Products International of Shawnee, Kansas can be used. Materials such as SUPERTHERM™ can be applied to the interior and/or exterior of the containers. Specifically, the material can be applied to the material that provides structural support to the container. Additionally or alternatively, such a material can be applied to another material that is used to insulate the container.

Various materials also can be used to form an outer shell of a container. Such an outer shell can be used to protect the inner material layers of the container and, thereby, improves the durability of the container. This can allow the container to be used more than once. Various durable materials such as ureas, *e.g.*, urea polymers and/or copolymers, cardboard, coatings that incorporate ceramics, such as SUPERTHERM™, epoxies, such as EPOXOTHERM™, and enamels, such polyurethane enamels, *e.g.*, ENAMOGRIPT™, can be used. Clearly, various other materials can be used to form an outer shell. Note, the material forming the outer shell also can provide enhancements in insulating characteristics of the container.

In some embodiments, bio-based insulating material can be applied to the material that is used to form the outer shell of the container. By way of example, when a cardboard box is used to form the outer shell, the bio-based insulating material, *e.g.*, bio-based polyurethane, can be applied directly to an interior of the cardboard box. Specifically, in some embodiments, the bio-based polyurethane can be sprayed onto the cardboard. In other embodiments, the bio-based insulating material may be poured onto the cardboard.

In some embodiments, the material used to form the insulation of a container also can be used to form an outer shell. In particular, various materials that form outer skins or hardened layers can be used. By way of example, ureas, *e.g.*, urea polymers and/or copolymers, can be used to form insulated structures that incorporate hardened outer surfaces. Also, materials configured as foams can be used to form insulated structures with hardened outer surfaces. These hardened outer surfaces or skins typically form as the material contacts the form into which the material is placed.

Various types of temperature-maintaining materials also can be used. By way of example, acrylate-based superabsorbents can be used. For instance, polacrylate/polyalcohol polymers and/or copolymers, such as AP85-38 manufactured by Emerging Technologies, Inc. of Greensboro, North Carolina, Norsocryl D-60, LiquiBlock, AT-03S, LiquiBlock 88, LiquiBlock 5 75, LiquiBlock 44-0C, among others can be used. In other embodiments, water and/or dry ice can be used in addition to, or in lieu of, other temperature-maintaining materials.

As described before, temperature-maintaining material can be incorporated into a container in various manners, such as by disposing the material between adjacent walls of the container and/or providing the temperature-maintaining materials in a package that can be placed 10 within the interior of the container. Note, in use, the polymers/copolymers are allowed to absorb liquid, such as water, and the temperature of the temperature-maintaining materials can be adjusted as desired.

As mentioned before, containers of the invention can be used for storing items, while maintaining, increasing or decreasing the temperature of the items stored in the containers. The 15 various functions associated with the containers of the invention will now be described with respect to several flowcharts. In this regard, FIG. 23 is a flowchart depicting a method in accordance with the invention.

As shown in FIG. 23, the method may be construed as beginning at block 502, where an embodiment of a container of the invention is provided. In block 504, an item is placed in the 20 container. In block 506, the container with the item inserted therein can be transported.

Various items can be stored and/or transported within containers of the invention. For instance, food products, beverages, pharmaceutical products, and biological matter, such as plants, tissues, organs, and blood can be stored and/or transported within the containers. Clearly, various other items could be used with embodiments of the invention, particularly those items 5 that may require their respective temperatures to be maintained, reduced and/or increased for a period of time, such as during transport.

As depicted in FIG. 24, another method in accordance with the invention may be construed as beginning at block 522, where a container is provided. In block 524, the temperature-maintaining material of the container is adjusted to exhibit a selected temperature. 10 By way of example, when the temperature-maintaining material is a refreezable material, the material can be frozen. In block 526, an item is placed within the container and, thereafter (block 528), the container with the item stored therein is transported. In block 530, the item is removed from the container, such as by accessing the storage chamber and removing the item from the storage chamber. Based upon the configuration of the container and the time the item has been 15 stored within the container, the item preferably exhibits desired temperature characteristics.

Another embodiment of a method of the invention is depicted in FIG. 25. As shown in FIG. 25, the method may be construed as beginning at block 540, where a container in accordance with the invention is provided in a disassembled or unfolded configuration. In block 542, the temperature of the temperature-maintaining material of the container is adjusted. In 20 block 544, the container is assembled and, such as depicted in block 548, an item is placed within a storage chamber of the assembled container. In block 550, the container with the item

inserted therein is transported to an intended destination and, in block 552, the item is removed from the container.

Several prototype containers were constructed in accordance with the invention and were subjected to testing. Results from the tests conducted will now be described.

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Example 1

In this example, a container was formed as a 6" x 6" x 6" box with 1.5" thick polyurethane insulation. The insulating material surrounded temperature-maintaining material in the form of a gel-forming polymer. Approximately 24 ounces of gel-forming polymer was located at the base of the container, 16 ounces of the polymer was located at the lid or top of the container. The item placed in the storage chamber was .74 lbs. of steak, which was placed into the storage chamber after the steak and the container were allowed to cool to a temperature of 4.9° F. The container with the item stored therein was then placed in an ambient environment which was approximately 75° F. The results of this example are depicted in FIG. 26.

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Example 2

In this example, another container (8.5" x 8.5" x 8.25") was formed with 1.5" polyurethane insulation. Twenty-four ounces of gel-forming polymer was located at the base, 16 ounces of gel-forming polymer was located at each of the sidewalls, 16 ounces of gel-forming polymer was located at the lid, and 4 ounces of gel-forming polymer was located at each of the 4 corners of the container. Ground beef, (1.87 lbs.) was inserted into the storage chamber, which

was then cooled to 35.8° F. After cooling, the container was placed in an ambient environment of approximately 75° F. As depicted in FIG. 27, the ground beef was maintained at or below 40° F for approximately 127 hours.

5           Example 3

In this example, a cylindrical container (see FIG. 10) was formed with 6 oz. of foam-type insulation. Five ounces of gel-forming polymer was located in a gap formed between the inner shell and the insert. The outer shell, insert and inner shell were formed of plastic.

The container was placed in a freezer, which was maintained at 1.5°F. Two cans of Bud  
10 Light® were placed in a refrigerator, which was maintained at 33.1 °F. After removing the container from the freezer, the cans were placed inside the container. The container with the stored can were then placed in a room with an ambient temperature of 75.5°F. Results are depicted in FIG. 28.

15           Example 4

The container used in example 3 was used again in this example. This time, the container was placed in a freezer, which was maintained at 3.6°F. Two cans of Bud Light® were placed in a refrigerator, which was maintained at 33.7°F. After removing the container from the freezer, the cans were placed inside the container, which was placed in a room with an ambient  
20 temperature of 75.5°F. Results are depicted in FIG. 29.

Example 5

The container used in examples 3 and 4 was used again in this example. Two cans of Diet Coke® were inserted in the container with the container exhibiting a temperature of 4.3° F at start, with each of the cans exhibiting a start temperature of 37.5° F. The container with the  
5 stored cans was then placed in an ambient environment of 70° F.

As depicted in FIG. 30, the beverages were maintained at temperatures of less than 37° F for approximately two hours. Due to the large number of data points, the curve shown represents a moving average of the data point values. Note, the temperature of the beverages dropped for approximately 30 minutes to 34° F and stabilized for approximately 90 minutes. The  
10 temperature began to rise and reached approximately 37° F at approximately 150 minutes, then continued to rise to 40° F at approximately 190 minutes.

Example 6

In this example, a container in a box-type configuration was used. Approximate  
15 dimensions of the container are 1.25' x 1.25'x 1.25'. Ten pouches of gel-forming polymer, weighing a total of 7.8 lbs., were used. The polymer was cooled to approximately 4° F and inserted into the storage chamber of the container. In particular, the bags were placed on the bottom, sides, corners and top of the storage chamber. Hamburger meat (3"x8"x4") weighing approximately 7.8 lbs. and exhibiting an initial temperature of 23.4° F was then placed in the  
20 container.

FIG. 31 shows the temperature profile which indicates that the meat climbed to a temperature of 32° F within one hour. The temperature at the gel/meat interface remained constant at 34° F for approximately 110 hours, then began a very slow increase to 39° F over the next 50 hours. After 166 hours, the container was opened and the meat was removed.

- 5     Approximately one inch of the meat against the gel packs appeared brown in color, while the center of the meat was natural red in color.

#### Example 7

In this example, the container of example 6 was used to determine the viability of  
10   antifreeze/gel-forming polymer-based refreezable material to maintain the temperature of items. In particular, one pint vanilla Haggendas® ice cream was placed in the container.

A 75:25 mixture of antifreeze (ethylene glycol) and water was mixed with 2.5 teaspoons of a dry polymer gel. Approximately 2.03 lbs. of the mixture was then dispensed into 6 Ziplock® bags and frozen in liquid nitrogen. The frozen bags and the ice cream, which had an  
15   initial temperature of 11° F, were placed in the storage chamber. The container was maintained at room temperature (72 – 74 ° F) for 68 hours. The results are depicted in the graph of FIGs. 31 and 32.

Some embodiments of containers may be well suited for use in a transportation process  
that includes the on-site production of the containers. For instance, when temperature-sensitive  
20   items are to be transported from one region to another, a transportation process may be used that includes producing the container at the site where the product is located. Referring now to FIG.

34, an embodiment of such a transportation process will be described in greater detail.

As shown in FIG. 34, an embodiment of a transportation process includes multiple regions. In FIG. 34, two such regions are depicted, *i.e.*, region A and region B. These regions can be defined in various manners. For instance, each of the regions can correspond to a particular geographic region, *e.g.*, region A could correspond to the Southeastern United States, while region B corresponds to the Northeastern United States.

In FIG. 34, each of the regions includes at least one customer and at least one product. In the example shown, region A includes a customer A, and a product A, region B includes a customer B and a product B. Note that a container production site is located in a vicinity of its respective product. For instance, with respect to product A, container production site A is located at the facility where product A is produced. Note that, although co-location at the product production facility is preferred, the container production site can be in a vicinity of the product location so that additional transportation costs are not incurred in order to provide the containers to the location from which the product will be transported.

In operation, materials required to produce a container are provided to the container production sites. After the materials have been provided, containers can be constructed. For example, in those embodiments incorporating foam, the foam can be blended and formed on-site. Advantageously, cost reductions in shipping products from one region to another can be potentially achieved in one or more of various respects. For example, the cost of providing a container can be reduced because a manufactured container does not need to be shipped to the product site. As another example, since the temperature-maintaining characteristics may enable

the use of ground transportation, the cost of air transportation may be avoided.

An embodiment of a transportation process such as that described before with respect to FIG. 34 will now be described with respect to the flowchart of FIG. 35. As shown in FIG. 35, the process may be construed as beginning at block 650, where an item is provided for transport.

- 5      In block 652, a container is provided for transported by the item. For example, the container can be provided by manufacturing the container in a vicinity of where the item is awaiting transport.
- 10     In block 654, the temperature of temperature-maintaining material included in the container is adjusted. For instance, when the item that is to be transported is to be maintained at a reasonably cool temperature, the temperature-material of the container can be frozen. In block 656, the item is transported to the destination within the container as depicted in block 658.

A schematic diagram of an embodiment of a transportation process is depicted in FIG. 36.

- As shown in FIG. 36, an item 670 is placed within a container 672 for transport. By way of example, the container can be constructed and/or configured in a manner described previously. The container with the items stored therein is located within a transport volume 674 that is defined, at least in part, by an insulating material 676. For example, the insulating material can comprise a bio-based polyurethane.

In the embodiment depicted in FIG. 36, the insulating material forms a portion of a shipping container that is transportable by a vehicle. For instance, a vehicle could be used for a ground transport such as by a truck or locomotive, or air transport. In other embodiments, the transport volume can be a portion of the vehicle itself. For instance, when the transport volume is a portion of a van, the insulating material could be applied to or could be a portion of the van

itself. Thus, a separate shipping container may not be used. In still other embodiments, a vehicle can define the container, and the item can be placed within the vehicle for transport with or without the item being placed within another container. By way of example, the exterior of the vehicle can be the outer shell of the container and the temperature-maintaining material can 5 comprise refrigerated air that can be provided by a refrigeration unit of the vehicle.

In FIG. 36, a refrigeration unit 680 is provided. The refrigeration unit provides cooling to the transport volume for enhancing the ability of the container to maintain the temperature of the item. By way of example, refrigeration unit 680 can be an air conditioner.

The foregoing description has been presented for purposes of illustration and description.

10 It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Modifications or variations are possible in light of the above teachings. The embodiment or embodiments discussed, however, were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are 15 suited to the particular use contemplated.

By way of example, a container can be provided with a device for determining whether the item stored therein is being maintained at a proper temperature. This can include, for example, providing a thermometer that directly measures the temperature of the item, or measure the temperature of the storage chamber. All such modifications and variations, are within the 20 scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly and legally entitled.